Claims

1. Use of an instrument for measuring a Raman signal of tissue, the instrument comprising a laser, a signal detection unit for measuring the Raman signal, and a fiber optic probe, wherein the fiber optic probe comprises one or more optical fibers for directing laser light onto the tissue and for collecting light that is scattered by the tissue and guiding the collected light away from the tissue towards the signal detection unit, the fiber comprising a core, a cladding and optionally a coating, and the fiber or fibers for collecting light having substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region, and wherein the detection unit records the Raman signal scattered by the tissue in said spectral region.

2. Use of an instrument according to claim 1, wherein the detection unit does substantially not measure fluorescence generated by other sources than the tissue.

3. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises at least one fiber having a low OH fused silica core.

4. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises at least one optical fiber having a fused silica core and a fused silica or Teflon or TECS cladding.

5. Use of an instrument according to one of the proceeding claims, by using a coating material in which intrinsically little or substantially no signal is generated in the 2500-3700 cm-1 wavenumber interval.

6. Use of an instrument according to one of the preceding claims, wherein the coating of the optical fiber comprises one or more of Teflon coatings and metal coatings.

7. Use of an instrument according to one of the preceding claims, wherein the detection unit substantially measures only the signal obtainable from the core of the optic fiber.

8. Use of an instrument according to one of the preceding claims, wherein the fiber comprises a first and a second coating, the first coating as coating on the cladding and the second coating as coating on the first coating, wherein the second coating comprises a laser light absorbing material.

9. Use of an instrument according to one of the preceding claims, wherein the fiber comprises a first and a second coating, the first coating as coating on the cladding and the second coating as coating on the first coating, wherein the second coating comprises a material having a higher refractive index than the first coating material.

10. Use of an instrument according to one of the preceding claims, wherein the optical fiber comprises a laser light absorbing end tip coating.

11. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises an optical fiber that both directs laser light onto the tissue and collects light that is scattered by the tissue and guides the collected light away from the tissue towards the signal detection unit, and wherein the fiber has substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region.

12. Use of an instrument according to one of the preceding claims, wherein the detection unit records the Raman signal in one or more parts of the 2700-3100 cm^{-1} spectral region.

13. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises an optical element at the distal end of the optical fiber.

14. Use of an instrument according to one of the preceding claims, further comprising a signal analysis unit which analyses the recorded Raman signal, the analysis comprising an algorithm which outputs data regarding the molecular composition of the tissue and/or the clinical diagnostic class to which the tissue belongs.

15. Use of an instrument according to one of the preceding claims for analysis and/or diagnosis of atherosclerotic plaque.

16. Use of an instrument according to one of the preceding claims for use in the analysis and/or diagnosis of cancerous tissue or pre-cancerous tissue.

17. Use of an instrument according to one of the preceding claims for skin diagnosis.

18. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe is integrated or combined with a catheter.

19. Use of an instrument according to one of the preceding claims, wherein Raman measurements can be combined with fluorescence and/or near-infrared absorption measurements and wherein the detection unit also comprises a detection unit for measuring the intensity and/or spectrum of tissue fluorescence and/or a detection unit for measuring near-infrared absorption.

20. Use of an instrument according to claim 19, wherein fluorescence and/or near-infrared absorption measurements make use of a fiber also used in obtaining Raman signal.

21. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises a bundle of fibers for measuring and/or scanning a tissue area.

22. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises one optical fiber, the fiber having substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region.

23. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe is brought in, or in contact with, or in proximity to the tissue under investigation.

24. Use of an instrument according to one of the preceding claims, wherein the tissue is excised, biopted or taken from a human or animal body before measuring.

25. An instrument for measuring a Raman signal of tissue, the instrument comprising a laser, a signal detection unit for measuring the Raman signal, and a fiber optic probe, wherein the fiber optic probe comprises one or more optical fibers for directing laser light onto the tissue and for collecting light that is scattered by the tissue and guiding the collected light away from the tissue towards the signal detection unit, the fiber comprising a core, a cladding and optionally a coating, and the fiber or fibers for collecting light having substantially no Raman signal in one or more parts of the 2500-3700 cm-1 spectral region, and wherein the detection unit records the Raman signal scattered by the tissue in said spectral region.

26. Instrument according to claim 25, wherein the detection unit does substantially not measure fluorescence generated by other sources than the tissue.

27. Instrument according to claim 25 or 26, wherein the fiber optic probe comprises at least one fiber.

28. Instrument according to one of claims 25-27, wherein the fiber optic probe comprises at least one optical fiber having a fused silica core and a fused silica or Teflon or TECS cladding.

29. Instrument according to one of claims 25-28, by using a coating material in which intrinsically little or substantially no signal is generated in the 2500-3700 cm-1 wavenumber interval.

30. Instrument according to one of claims 25-29, wherein the coating of the optical fiber comprises one or more of Teflon coatings and metal coatings.

31. Instrument according to one of claims 25-30, wherein the detection unit substantially measures only the signal obtainable from the core of the optic fiber.

32. Instrument according to one of claims 25-31, wherein the laser light is only coupled into the central core of the fiber.

33. Instrument according to one of claims 25-32, wherein the fiber comprises a first and a second coating, the first coating as coating on the cladding and the second coating as coating on the first coating, wherein the second coating comprises a laser light absorbing material.

34. Instrument according to one of claims 25-33, wherein the fiber comprises a first and a second coating, the first coating as coating on the cladding and the second coating as coating on the first coating, wherein the second coating comprises a material having a higher refractive index than the first coating material.

35. Instrument for measuring a Raman signal of tissue according to one of claims 25-34, wherein the fiber optic probe comprises an optical fiber that both directs laser light onto the tissue and collects light that is scattered by the tissue and guides this collected light away from the tissue towards the signal detection unit, and wherein the fiber has substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region.

36. Instrument according to one of claims 25-35, wherein the detection unit also comprises a detector for measuring fluorescence and/or a detector for near-infrared absorption.

37. Instrument according to one of claims 25-36 wherein fluorescence and/or near-infrared absorption measurements make use of a fiber also used in obtaining Raman signal and wherein the detection unit also comprises a detector for measuring fluorescence and/or a detector for near-infrared absorption.

38. Instrument according to one of claims 25-37 wherein the fiber optic probe comprises a bundle of fibers for measuring and/or scanning a tissue area.

39. Instrument according to one of claims 25-38, wherein the fiber optic probe comprises one optical fiber, the fiber having substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region.

40. Instrument according to one of claims 25-39, wherein the optical fiber comprises a laser light absorbing end tip coating.

41. Instrument according to one of claims 25-40, wherein the end face of the optical fiber, where the laser light is coupled into the optical fiber, is polished.

42. A method for producing and measuring a Raman signal of tissue, comprising providing a laser, a detection unit for measuring a Raman signal, and a fiber optic probe, wherein the fiber optic probe comprises one or more optical fibers for directing laser light onto the tissue and for collecting light that is scattered by the tissue and guiding the collected light away from the tissue toward the signal detection unit, the fiber comprising a core, a cladding and optionally a coating, sending laser light through the one or more optical fibers, receiving the Raman signal from the tissue through the one or more optical fibers and detecting the Raman signal by a signal detection unit, the fiber or fibers for collecting light having substantially no Raman signal in one or more parts of the 2500-3700 cm-1 spectral region, and wherein the signal detection unit records the Raman signal in said spectral region.

43. Method according to claim 41, further comprising sending the laser light through a same optical fiber which also receives the Raman signal, using an optical fiber for this method which has substantially no Raman signal in one or more parts of the 2500-3700 cm-1 spectral region

44. A method for measuring a Raman signal of a tissue sample, wherein an instrument according to one of claims 25-41 is used and wherein the tissue sample is excised, biopted or taken from a human or animal body before measuring.

45. Method for evaluating an optical fiber for measuring a Raman signal of tissue, wherein an instrument according to one of claims 25-41 is used and wherein a tissue sample is excised, biopted or taken from a human or animal body before measuring, and wherein the Raman signal of the optical fiber is measured of the sample and of a blanc, and wherein the Raman signals of the sample and of the blanc are compared.

46. Method for evaluating the suitability of a type of fiber for measuring the Raman signal of tissue, comprising:
- using an instrument according to one of claims 25-41
- performing a measurement without tissue being present at the distal end of the fiber,
- performing a measurement with tissue being present at the distal end of the fiber,
- comparing the spectra obtained with and without tissue being present
- concluding that the fiber is suitable for measuring the Raman signal of tissue.

Replaced by Art. 34

AMENDED CLAIMS

[Received by the International Bureau on 10 May 2004 (10.05.04): original claims 1-46 replaced by amended/new claims 1-44]

1. Use of an instrument for measuring a Raman signal of tissue, the instrument comprising a laser, a signal detection unit for measuring the Raman signal, and a fiber optic probe, wherein the fiber optic probe comprises one or more optical fibers for directing laser light onto the tissue and for collecting light that is scattered by the tissue and guiding the collected light away from the tissue towards the signal detection unit, the fiber comprising a core, a cladding and optionally a coating, and the fiber or fibers for collecting light having substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region, and wherein the detection unit records the Raman signal scattered by the tissue in said spectral region, and wherein the fiber optic probe comprises an optical fiber that both directs laser light onto the tissue and collects light that is scattered by the tissue and guides the collected light away from the tissue towards the signal detection unit, and wherein the fiber has substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region.

2. Use of an instrument according to claim 1, wherein the detection unit does substantially not measure fluorescence generated by other sources than the tissue.

3. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises at least one fiber having a low OH^- fused silica core.

4. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises at least one optical fiber having a fused silica core and a fused silica or Teflon or TECS cladding.

5. Use of an instrument according to one of the proceeding claims, by using a coating material in which intrinsically little or substantially no signal is generated in the 2500-3700 cm^{-1} wavenumber interval.

6. Use of an instrument according to one of the preceding claims, wherein the coating of the optical fiber comprises one or more of Teflon coatings and metal coatings.

7. Use of an instrument according to one of the preceding claims, wherein the detection unit substantially measures only the signal obtainable from the core of the optic fiber.

8. Use of an instrument according to one of the preceding claims, wherein the fiber comprises a first and a second coating, the first coating as coating on the cladding and the second coating as coating on the first coating, wherein the second coating comprises a laser light absorbing material.

9. Use of an instrument according to one of the preceding claims, wherein the fiber comprises a first and a second coating, the first coating as coating on the cladding and the second coating as coating on the first coating, wherein the second coating comprises a material having a higher refractive index than the first coating material.

10. Use of an instrument according to one of the preceding claims, wherein the optical fiber comprises a laser light absorbing end tip coating.

11. Use of an instrument according to one of the preceding claims, wherein the detection unit records the Raman signal in one or more parts of the 2700-3100 cm^{-1} spectral region.

12. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises an optical element at the distal end of the optical fiber.

13. Use of an instrument according to one of the preceding claims, further comprising a signal analysis unit which analyses the recorded Raman signal, the analysis comprising an algorithm which outputs data regarding the molecular composition of the tissue and/or the clinical diagnostic class to which the tissue belongs.

14. Use of an instrument according to one of the preceding claims for analysis and/or diagnosis of atherosclerotic plaque.

15. Use of an instrument according to one of the preceding claims for use in the analysis and/or diagnosis of cancerous tissue or pre-cancerous tissue.

16. Use of an instrument according to one of the preceding claims for skin diagnosis.

17. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe is integrated or combined with a catheter.

18. Use of an instrument according to one of the preceding claims, wherein Raman measurements can be combined with fluorescence and/or near-infrared absorption measurements and wherein the detection unit also comprises a detection unit for measuring the intensity and/or spectrum of tissue fluorescence and/or a detection unit for measuring near-infrared absorption.

19. Use of an instrument according to claim 18, wherein fluorescence and/or near-infrared absorption measurements make use of a fiber also used in obtaining Raman signal.

20. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises a bundle of fibers for measuring and/or scanning a tissue area.

21. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe comprises one optical fiber, the fiber having substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region.

22. Use of an instrument according to one of the preceding claims, wherein the fiber optic probe is brought in, or in contact with, or in proximity to the tissue under investigation.

23. Use of an instrument according to one of the preceding claims, wherein the tissue is excised, biopted or taken from a human or animal body before measuring.

24. An instrument for measuring a Raman signal of tissue, the instrument comprising a laser, a signal detection unit for measuring the Raman signal, and a fiber optic probe, wherein the fiber optic probe comprises one or more optical fibers for directing laser light onto the tissue and for collecting light that is scattered by the tissue and guiding the collected light away from the tissue towards the signal detection unit, the fiber comprising a core, a cladding and optionally a coating, and the fiber or fibers for collecting light having substantially no Raman signal in one or more parts of the 2500-3700 cm-1 spectral region, and wherein the detection unit records the Raman signal scattered by the tissue in said spectral region, and wherein the fiber optic probe comprises an optical fiber that both directs laser light onto the tissue and collects light that is scattered by the tissue and guides the collected light away from the tissue towards the signal detection unit, and wherein the fiber has substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region.

25. Instrument according to claim 24, wherein the detection unit does substantially not measure fluorescence generated by other sources than the tissue.

26. Instrument according to claim 24 or 25, wherein the fiber optic probe comprises at least one fiber.

27. Instrument according to one of claims 24-26, wherein the fiber optic probe comprises at least one optical fiber having a fused silica core and a fused silica or Teflon or TECS cladding.

28. Instrument according to one of claims 24-27, by using a coating material in which intrinsically little or substantially no signal is generated in the 2500-3700 cm-1 wavenumber interval.

29. Instrument according to one of claims 24-28, wherein the coating of the optical fiber comprises one or more of Teflon coatings and metal coatings.

30. Instrument according to one of claims 24-29, wherein the detection unit substantially measures only the signal obtainable from the core of the optic fiber.

31. Instrument according to one of claims 24-30, wherein the laser light is only coupled into the central core of the fiber.

32. Instrument according to one of claims 24-31, wherein the fiber comprises a first and a second coating, the first coating as coating on the cladding and the second coating as coating on the first coating, wherein the second coating comprises a laser light absorbing material.

33. Instrument according to one of claims 24-32, wherein the fiber comprises a first and a second coating, the first coating as coating on the cladding and the second coating as coating on the first coating, wherein the second coating comprises a material having a higher refractive index than the first coating material.

34. Instrument according to one of claims 24-33, wherein the detection unit also comprises a detector for measuring fluorescence and/or a detector for near-infrared absorption.

35. Instrument according to one of claims 24-34 wherein fluorescence and/or near-infrared absorption measurements make use of a fiber also used in obtaining Raman signal and wherein the detection unit also comprises a detector for measuring fluorescence and/or a detector for near-infrared absorption.

36. Instrument according to one of claims 24-35 wherein the fiber optic probe comprises a bundle of fibers for measuring and/or scanning a tissue area.

37. Instrument according to one of claims 24-36, wherein the fiber optic probe comprises one optical fiber, the fiber having substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region.

38. Instrument according to one of claims 24-37, wherein the optical fiber comprises a laser light absorbing end tip coating.

39. Instrument according to one of claims 24-38, wherein the end face of the optical fiber, where the laser light is coupled into the optical fiber, is polished.

40. A method for producing and measuring a Raman signal of tissue, comprising providing a laser, a detection unit for measuring a Raman signal, and a fiber optic probe, wherein the fiber optic probe comprises one or more optical fibers for directing laser light onto the tissue and for collecting light that is scattered by the tissue and guiding the collected light away from the tissue toward the signal detection unit, the fiber comprising a core, a cladding and optionally a coating, sending laser light through the one or more optical fibers, receiving the Raman signal from the tissue through the one or more optical fibers and detecting the Raman signal by a signal detection unit, the fiber or fibers for collecting light having substantially no Raman signal in one or more parts of the 2500-3700 cm-1 spectral region, and wherein the signal detection unit records the Raman signal in said spectral region, and wherein the fiber optic probe comprises an optical fiber that both directs laser light onto the tissue and collects light that is scattered by the tissue and guides the collected light away from the tissue towards the signal detection unit, and wherein the fiber has substantially no Raman signal in one or more parts of the 2500-3700 cm^{-1} spectral region.

41. Method according to claim 40, further comprising sending the laser light through a same optical fiber which also receives the Raman signal, using an optical fiber for this method which has substantially no Raman signal in one or more parts of the 2500-3700 cm-1 spectral region

AMENDED SHEET (ARTICLE 19)

42. A method for measuring a Raman signal of a tissue sample, wherein an instrument according to one of claims 24-39 is used and wherein the tissue sample is excised, biopted or taken from a human or animal body before measuring.

43. Method for evaluating an optical fiber for measuring a Raman signal of tissue, wherein an instrument according to one of claims 24-39 is used and wherein a tissue sample is excised, biopted or taken from a human or animal body before measuring, and wherein the Raman signal of the optical fiber is measured of the sample and of a blanc, and wherein the Raman signals of the sample and of the blanc are compared.

44. Method for evaluating the suitability of a type of fiber for measuring the Raman signal of tissue, comprising:

- using an instrument according to one of claims 24-39
- performing a measurement without tissue being present at the distal end of the fiber,
- performing a measurement with tissue being present at the distal end of the fiber,
- comparing the spectra obtained with and without tissue being present
- concluding that the fiber is suitable for measuring the Raman signal of tissue.